§2. Directivity Improvement of a Loop Antenna for Polarization Measurement of Electron Cyclotron Wave

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Various interesting phenomena occur in the ECR region of the Hyper-I plasma: macroscopic flow generation and spontaneous structure formation. The origins of these phenomena, however, have not been clear yet. We have been studying the mechanism in terms of the plasma production.

For this purpose, we have been developing an antenna, which has a sufficient directivity to measure two different wave components individually and can be used under the circumstances with the presence of high power microwaves. The antenna should also be as compact as possible to minimize the disturbance to plasmas. The compactness is also required to achieve sufficient spatial resolution.

At first, we performed the directivity test for ordinary loop antenna, which has an area of $8mm^2$, with TE_{10} mode microwave propagating in a rectangular waveguide. Under such conditions, the wave magnetic field has a component parallel to one side of rectangle only. Therefore the received power is definitely proportional to $\cos^2\theta$, where θ is an angle between the normal vector of the loop antenna and the wave magnetic field. Here, we introduce a fitting function: $P = (P_1 \cos(\theta - \theta_0) + P_2)^2$. If the antenna is ideal, the value of P_2/P_1 must be equal to zero. As shown in Fig. 1, the experimental values, which are plotted as solid circles, are far from the ideal ones, and the ratio is $P_2/P_1=5.88$. Therefore, the loop antenna straightforwardly downsized cannot be used for the polarization measurement.

In order to improve the directivity, we have developed a new antenna, which is shown in Fig. 2. The tip is covered by a stainless steel case with a slit. Because of the shielding effect of this slit, the antenna detects only one magnetic field component penetrating through the slit. Countermeasure to heat of the Hyper-I plasma is provided by heatproof coaxial cable, in which MgO powder is used for insulation. Figure 3 shows the result of the directivity test for the new antenna with slit-case. The experimental values are in good agreement with the ideal ones, and the value of $P_2/P_1=0.009$, which is remarkably close to zero.

In conclusion, the effectiveness of the slit-case to directivity is experimentally confirmed with TE_{10} mode microwave propagating in a rectangular waveguide. Application to the Hyper-I plasma is now in progress.

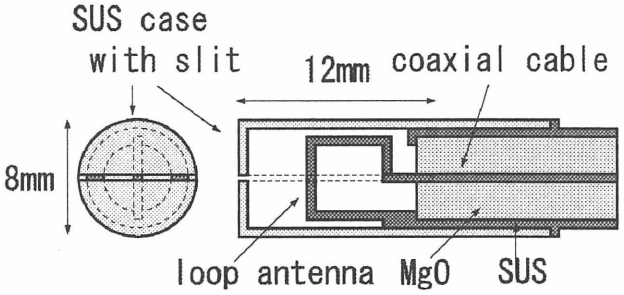

Fig. 2 Schematic of the new antenna w/ slit-case. The loop area is 8.0 mm^2.

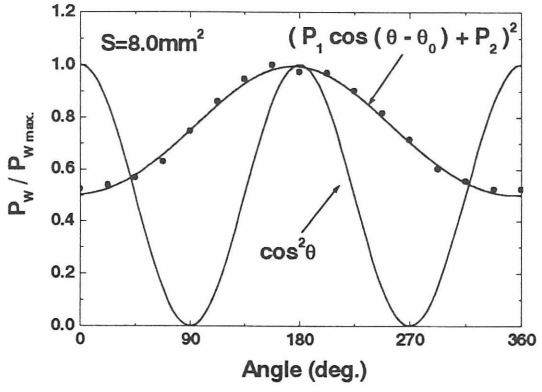

Fig. 1 Directivity of the loop antenna w/o slit-case. $P_2/P_1=5.88$.

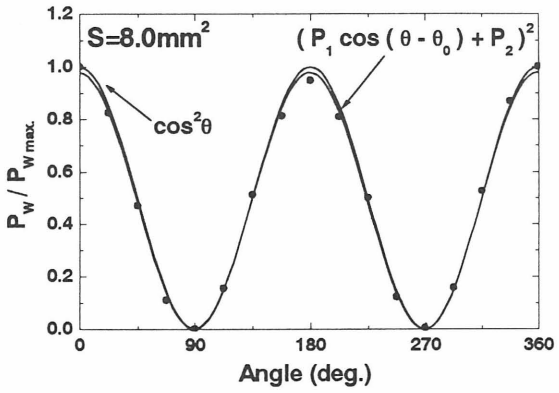

Fig. 3 Directivity of the loop antenna w/ slit-case. $P_2/P_1=0.009$.